experiences in the Merv region at the Geographical Society's meeting on March 27.

DR. A. E. REGEL, well-known through his travels, undertook a new journey to Central Asiatic districts which have never been visited by a European before, and has now returned richly laden with scientific treasures. He began his work with an investigation of the Matchi Valley near the Zarawshan glaciers, crossed the mountain passes of Pakchif and Sagridetch, and reached the towns of Kala and Chumba, which stand upon the high plateau of the Amu Daria. Concerning this part he made interesting ethnographical observations. The type of the population of these districts is a mixed one; in Darwas the type of Aryans has remained pure, yet the hair is not always black, lighter shades being frequently met with; sometimes the head is completely shaved. The women do not cover their faces and marry according to their choice; their faces are almost European in appearance, sometimes gipsy like. The language at Darwas varies but little from that spoken at Bokhara and Samarkand. Quite another language is found at Shugnan, which sounds almost like a European language, as do also the national songs of these people.

A RUSSIAN staff-officer, who is said to have followed Col. C. E. Stewart's example by disguising himself as a merchant, and appears to have been recently travelling about in Khorassan, has published in the *Nouveau Temps* some interesting papers on the country and its Kurdish inhabitants.

CAPTAIN VON WOHLGEMUTH, of the Austrian Navy, has been appointed leader of the Austrian Polar expedition to establish an observing station at Jan Mayen. The steamer, which will leave Pola early in April next, is now being fitted out most energetically.

THE Geographical Society of the Pacific, founded at San Francisco last summer, have just issued the first number of their *Proceedings*, which is entirely occupied by a paper prepared for the Society by Capt. Hooper, on the recent cruise of the *Corwin* in the Arctic Sea. In addition to the account of his visit to Wrangel Land, &c., Capt. Hooper gives some details as to the manners and customs of the Chukches. Capt. Hooper proposes to deal with the very important subject of currents in another paper, but he makes a few remarks on the influence of the Kuro-siwo or Japanese warm stream on the waters of Behring Strait, &c.; and he also furnishes a table showing his determination of the magnetic declination and dip in the Arctic regions, from the end of May to the beginning of October, 1881.

THE new number of the American Geographical Society's *Bulletin* contains an account by Commander H. H. Gorringe U.S.N., on a cruise along the northern coast of Africa, and a paper by Mr. Jas. Douglas, jun., on the Geography, People, and Institutions of Chile.

ON THE SENSE OF COLOUR AMONG SOME OF THE LOWER ANIMALS[1]

AS I have already mentioned in a previous communication (*Journ.* Linn. Soc. vol. xv. p. 376 (Part No. 87), M. Paul Bert (*Archiv. de Physiol.* 1869, p. 547) has made some very interesting experiments on a small freshwater crustacean belonging to the genus *Daphnia*, from which he concludes that they perceive all the colours known to us, being, however, especially sensitive to the yellow and green; and that their limits of vision are the same as ours.

Nay, he even goes further than this, and feels justified in concluding, from the experience of two species—Man and *Daphnia* —that the limits of vision would be the same in all cases.

His words are :—

A. "Tous les animaux voient les rayons spectraux que nous voyons."

B. "Ils ne voient aucun de ceux que nous ne voyons pas."

C. "Dans l'étendue de la région visible, les différences entre les pouvoirs éclairants des différents rayons colorés sont les mêmes pour eux et pour nous."

He also adds that, "puisque les limites de visibilité semblent être les mêmes pour les animaux et pour nous, ne trouvons-nous pas là une raison de plus pour supposer que le rôle des milieux de l'œil est tout-à-fait secondaire, et que la visibilité tient à l'impressionnabilité de l'appareil nerveux lui-même."

[1] Paper read at the Linnean Society on November 17, 1881, by Sir John Lubbock, Bart, M.P., F.R.S., President.

These generalisations would seem to rest on a very narrow foundation. I have already attempted to show that the conclusion does not appear to hold good in the case of ants, and I determined therefore to make some experiments myself on Daphnias, the results of which are embodied in the present communication.

Prof. Dewar was kind enough again to arrange for me a spectrum, which, by means of a mirror, was thrown on to the floor. I then placed some Daphnias in a wooden trough 14 inches by 4 inches, and divided by cross partitions of glass into divisions, so that I could isolate the parts illuminated by the different-coloured rays. The two ends of the trough extended somewhat beyond the visible spectrum. I then placed fifty specimens of *Daphnia pulex* in the trough, removing the glass partitions so that they could circulate freely from one end of the trough to the other. Then, after scattering them equally through the water, I exposed them to the light for ten minutes, after which I inserted the glass partitions, and then counted the Daphnias in each division. The results were as follows :—

Number of Daphnias

	Beyond the blue.	In the red and yellow.	In the greenish yellow and green.	In the blue.	In the violet.	Beyond the violet.
Obs. 1. ...	0	20	28	2	0	0
,, 2. ...	1	21	25	3	0	0
,, 3. ...	2	21	24	3	0	0
,, 4. ...	1	19	29	1	0	0
,, 5. ...	0	20	27	3	0	0
	4	101	133	12	0	0

I may add that the blue and violet divisions were naturally longer than the red and green.

May 25.—Tried again the same arrangement, but separating the yellow, and giving the Daphnias the choice between red, yellow, green, blue, violet and dark :—

	Dark.	Violet.	Blue.	Green.	Yellow.	Red.
Exp. 1. ...	0	0	3	39	5	3
,, 2. ...	0	1	2	37	7	3
,, 3. ...	0	0	4	31	10	5
,, 4. ...	0	1	5	30	8	6
,, 5. ...	0	1	4	33	6	6
	0	3	18	170	36	23

Of course it must be remembered that the yellow band is much narrower than the green. I reckoned as yellow a width of ¾ inch, and that of the green 2 inches.

Again,

	Dark.	Violet.	Blue.	Green.	Yellow.	Red.
Exp. 1. ...	0	0	4	30	6	10
,, 2. ...	0	1	3	25	8	13
,, 3. ...	0	0	2	24	9	15
,, 4. ...	1	0	3	25	8	13
,, 5. ...	0	1	2	24	7	16
	1	2	14	128	38	67

M. Paul Bert observes (*l. c.*) that in his experiments the Daphnias followed exactly the brilliancy of the light. It will be observed, however, that in my experiments this was not the case; as there were more Daphnias in proportion, as well as absolutely, in the green, although the yellow is the brightest portion of the spectrum.

May 18.—The same arrangement as before. In order to test the limits of vision at the red end of the spectrum, I used the trough so that the extreme division was in the ultra-red and the second in the red. I then placed 60 Daphnias in the ultra-red. After five minutes' exposure I counted them. There were in the

	Red.	Ultra-red.
Exp. 1.	54	5
,, 2.	56	4
	110	9

I now gave them four divisions—dark, red, ultra-red, and dark again. The numbers were :—

	Dark.	Red.	Ultra-red.	Dark.
Exp. 1.	5	47	6	2
,, 2.	9	41	7	3
	14	88	13	5

It seems clear, therefore, that the ultra-red is to them practically the same as darkness.

I then so arranged the trough that the yellow fell in the middle of one of the divisions. The result was :—

Number of Daphnias

	Ultra-red and lower red.	Upper edge of red, yellow, and lower green.	Greenish blue and blue.	Violet.	Ultra-violet.
Exp. 1. ...	8	38	4	0	0
,, 2. ...	9	36	5	0	0
,, 3. ...	8	39	3	0	0
	25	113	12	0	0

I then shut them off from all the colours excepting red, giving them only the option between red and ultra-red :—

	Red.	Ultra-red.
Exp. 1.	46	4
,, 2.	47	3
,, 3.	44	6
	137	13

I then left them access to a division on the other side of the red, which, however, I darkened by interposing a piece of wood. This enabled me better to compare the ultra-red rays with a really dark space :—

	Dark.	Red.	Ultra-red.
Exp. 1.	4	43	3
,, 2.	3	45	2
	7	88	5

Certainly, therefore, their limits of vision at the red end of the spectrum seem approximately to coincide with ours.

I then proceeded to examine their behaviour with reference to the other end of the spectrum.

Ultra-violet.	Dark.
58	2
286	14

Not satisfied with this I tried to test it in another way.

I then shut them off from all the rays except the blue, violet, and ultra-violet. The result was as follows :—

Number of Daphnias

	Ultra-violet.	Violet.	Blue.	Dark.
Exp. 1.	1	9	38	2
,, 2.	4	6	38	2
,, 3.	0	2	46	2
	5	17	122	6

I then gave them only the option of ultra-violet, violet, and darkness :—

	Ultra-violet.	Violet.	Dark.
Exp. 1.	8	48	4
,, 2.	6	48	6
,, 3.	12	47	1
,, 4.	15	42	3
,, 5.	4	53	3
	45	238	17

I then tried ultra-violet and dark. The width of the violet was 2 inches; and I divided the ultra-violet portion again into divisions each of 2 inches, which we may call ultra-violet, further ultra-violet, and still further ultra-violet. The results were :—

Number of Daphnias

	Still further ultra-violet.	Further ultra-violet.	Ultra-violet.	Dark.
Exp. 1.	0	6	52	2
,, 2.	0	5	52	3
,, 3.	0	6	50	4
,, 4.	0	4	53	3
,, 5.	0	4	54	2
	0	25	261	14

May 18.—I then again tried them with the ultra-violet rays, using three divisions, namely, further ultra-violet, ultra-violet, and dark. The numbers were as follows, viz. under the

	Further ultra-violet.	Ultra-violet.	Dark.
Exp. 1.	6	50	4
,, 2.	3	55	2
	9	105	6

To my eye there was no perceptible difference between the further ultra-violet and the ultra-violet portion; but slightly undiffused light reached the two extreme divisions. It may be asked why the still further ultra-violet division should have been entirely deserted, while in each case two or three Daphnias were in the darkened one. This, I doubt not, was due to the fact that the darkened division being next to the ultra-violet, one or two in each case straggled into it.

I then placed over the ultra-violet division a glass cell containing a layer of sulphate of quinine about ⅝ inch in depth, and over the further ultra violet a similar cell with water. I had expected that the great majority would have collected under the water-cell. The numbers, however, were :—

	Further ultra-violet with cell containing water.	Ultra-violet with cell containing sulphate of quinine.
Exp. 1.	8	50
,, 2.	4	54
,, 3.	11	49
,, 4.	4	56
	27	209

The reason of this, however, seemed evident as soon as I tried the experiment; because though the sulphate of quinine stops the ultra-violet rays, it turns them into blue light, and, to our eyes at least, actually increases the brilliance.

I then took a cell in which I placed a layer of 5 per cent. solution of chromate of potash less than an eighth of an inch in depth, which, though almost colourless to our eyes, completely cut off the ultra-violet rays. I then turned my trough at right angles, so that I could cover one side of the ultra-violet portion of the spectrum with the chromate and leave the other exposed. The numbers were as follows :—

	Side of the ultra-violet covered with chromate of potash.	Side uncovered.	Dark.
Exp. 1.	5	55	0
I now covered up the other side.			
,, 2.	3	57	0
Again covered up the same side as at first.			
,, 3.	4	56	0
Again covered up the other side.			
,, 4.	3	57	0

May 19.—Again the same arrangement. I reduced the chromate of potash to a mere film, which, however, still cut off the ultra-violet rays. I then placed it, as before, over one-half of the ultra-violet portion of the spectrum, and over the other half I placed a similar cell containing water. Between each experiment I reversed the position of the two cells. The numbers were :—

	Under the film of chromate of potash.	Under the water.
Exp. 1.	8	52
,, 2.	4	56
,, 3.	10	50
,, 4.	7	53
	29	211

Evidently even a film of chromate of potash exercises a very considerable influence; and indeed I doubt not that if a longer time had been allowed, the difference would have been even greater.

It seems clear, therefore, that a film of a 5 per cent. solution of chromate of potash only ⅛ inch in thickness, which cuts off the ultra-violet rays, though absolutely transparent to our eyes, is by no means so to the Daphnias.

I then again returned to the sulphate of quinine; but instead of placing it close to the water, I suspended it at a height of 3

feet, so that the Daphnias were far less directly illuminated by the scattered light.

As in the preceding case, I placed by the side of it a similar cell containing water, and suspended them side by side over the water containing the Daphnias, and reversing the position after each experiment. The numbers were as follows:—

	Under the sulphate of quinine.	Under the water.
Exp. 1.	13	47
„ 2.	17	43
„ 3.	12	48
„ 4.	11	49
„ 5.	20	40
„ 6.	18	42
„ 7.	20	40
„ 8.	15	45
	126	354

Although the contrast in this latter series is not so great, still it is unmistakable. It seems to me, therefore, though I differ with great reluctance from so eminent an authority as M. Paul Bert, that the limits of vision of Daphnias do not, at the violet end of the spectrum, coincide with ours, but that the Daphnia, like the ant, is affected by the ultra-violet rays.

GLACIERS AND GLACIAL PERIODS IN THEIR RELATIONS TO CLIMATE[1]

NOW that the *effects* of glacial action, present and past, have been so well studied, the question as to *causes* deserves to be more attentively considered, and it seems that meteorologists must now take it in hand, having too long neglected it. A cursory glance on the present conditions of our globe shows us that cold alone will not produce permanent snow and glaciers when vapour of water is deficient. There are no permanent snow nor glaciers in the Verkhojansk Mountains in North-East Siberia, yet at the foot of them the mean annual temperature is below 4° F., and that of January below − 56° F. The reason is that the snowfall is but small, and thus the snow is easily melted in summer. In New Zealand, on the contrary, owing to the enormous snowfall in the mountains, glaciers descend to about 700 feet above sea-level on the west side (lat. 43° S.). At this height the mean annual temperature must be about 50° F., and snowfall and frost are of rare occurrence, even in winter.

The great importance of an abundant supply of vapour admitted, and thus the necessity of surfaces covered by sea, what temperature of the surface of the seas is the most favourable to the production of glaciers? This depends certainly on the height above sea-level where the *nevé* is formed; but so far as we consider lowlands and moderate heights, say below 6000 feet, the surface temperature of the water should not very much exceed the freezing point, otherwise the vapour evaporated from the sea and condensed on the surrounding lands will be rain, and not snow, thus contributing rather to melt the existing snow and not to form new snow-layers. For lowlands and very small elevations a temperature of the surrounding seas of about 32° F. is that which is most favourable to the formation of snow, and if the last is falling in sufficient quantities to form permanent snow and glaciers.

The deeper and opener the seas are, the better, for such seas do not freeze entirely, as the winds and tides always break the ice which is already formed; thus seas of that kind have, even in the midst of winter, a considerable open surface, which evaporates freely. Shallow seas surrounded by land can be entirely frozen in winter, and thus the ice and snow which cover them, considerably cooled by radiation and cold winds from the land, evaporate but very little, and are by far less favourable to a great precipitation of snow and ice. Thus the cold of winter in mediterranean seas is a condition very unfavourable to a great evaporation from their surface in the cold season, and to a heavy snowfall on the surrounding land. With the premises given above it will be easy to understand the difference in the extent of ice-sheets and glaciers, or their total absence in the different regions of our globe at the present time, as well as the probable causes of former glaciation.

Abstracting for once from the polar regions of the southern hemisphere, of which we know but little, we see that in the higher latitudes of the southern hemisphere (40°–67°) the extent of seas is much greater than in the same latitudes of the northern hemisphere. We know, further, that the seas of these latitudes receive considerable quantities of warm water from tropical seas. Now the south tropical seas do not exceed so much in extent the north tropical seas, then the seas between 40°–67° S. exceed the seas between 40°–67° N. If the latter were even to receive the same relative proportion of warm water from the tropical seas of their own hemisphere than the southern seas of the same parallels, the thermal effect would be yet greater, on account of the limited extent of the seas between 40°–67° N. But the greater extension of the south-east trades and their existence even to the north of the equator pours a great quantity of the warm water of the southern tropical seas into the seas of the north temperate zone, thus giving probably an equal if not a superior quantity of warm water to seas of not half the extent. How much this must tend to raise the temperature of the seas between 40°–67° N. is easy to see. This explains why there is so little permanent snow in these northern latitudes in the proximity of the sea, notwithstanding the great precipitation existing there, and the greatest quantity of it falling in the colder part of the year. The temperature of the sea-surface is so high, that much more rain than snow falls even in winter. Let us take an example. The sea-surface between the south-west of England and the south of Ireland has a temperature of above 50° F. even in January. Supposing a saturated stratum of air to rise from these seas, it would have cooled down to about 38·4° F. at an elevation of 4000 feet, that is at the level of the highest peaks of the British Islands.[1] The resulting precipitation will be rain and not snow. Thus a broad and swift atmospherical current from the south-west will give rain and not snow, even in the mountains of England and Scotland. As the south-west are the prevailing winds the absence of anything like permanent snow is easily understood. In Norway, where the surrounding seas are colder and the elevations greater, permanent snow and glaciers do exist. Greenland, which is surrounded by much colder seas, yet never entirely frozen, has an ice-sheet covering all the interior and forcing glaciers to the sea. The height of the ice-sheet is so great, and the sea so cold, that probably even in summer the precipitation is always snow in the interior. As the seas near Greenland are not warmer than 41° F. in summer, a saturated stratum of air rising from them will have a temperature of about 31·1° F. at a height of 3000 feet, that is, much below the level of the ice-sheet in the interior.

The seas between 40–67° S. have generally a much lower temperature than the northern seas of the same latitude (see, for example, the map in Wild's "Thalassa.") Thus their conditions are much more favourable to the production of snow at small elevations above the sea-level, and owing to the small difference of the temperature of winter and summer in so strictly oceanic climates, snow will fall even in summer. This explains why we find so great sheets of ice and glaciers descending to sea-level in all lands and islands south of 50° S. (the eastern part of South America, the Falkland and Auckland Islands excepted).

As there is either a continent or a great cluster of high islands in high southern latitudes, and as the seas north of it give great quantities of moisture to be condensed to snow, a glaciation exceeding all that is known in the north hemisphere is the result, and the glaciers, descending to the sea, and their broken ends floating to the ocean as icebergs, they in their turn cool the sea water, and thus bring about temperatures favourable to the formation of snow. Thus cause and effect react on each other, as is so often the case. We know besides that the southern seas do not freeze to a great extent, so that ice-fields, so frequent in higher northern latitudes, are far less common in the south, the icebergs being the prevailing form of ice there. This shows us that there is, on the southern seas, always a great extent of open water, and thus an active evaporation.

In the northern hemisphere, on the contrary, the colder seas are mostly shallow and surrounded by land, and thus frozen over to a great extent in winter (for example, the White and Kara Seas, the Sea of Okhotsk, Hudson's Bay, the bays and straits between the archipelago of North America). Thus the evaporation is checked just at the time most favourable to a heavy snowfall.

The continents of the northern hemisphere are too extensive, too little open to the influences of the sea and its moisture, to have extensive ice-sheets. The example of mountains in North-East Siberia shows this very well. Similarly the great interior

[1] Short analysis of my paper under the same title, published by the *Zeitschrift der Gesellschaft für Erdkunde* in 1881.

[1] On the Thermal Conditions of Rising and Descending Strata of Air. See Guldberg and Mohn's "Etudes sur les Mouvements de l'Atmosphère."